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Beta Acid Extracts of Hops Have a Modest Effect on Ruminal Metabolism and Apparent Total Tract Digestibility by Steers Fed High-Concentrate Diets[1]

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Introduction

Hops have been used for centuries to control bacterial contamination in beer production. Today, alpha acids are extracted from hops for use in flavoring beer, leaving residues that are rich in beta acids. Beta acid fractions of hops can selectively inhibit specific ruminal Gram-positive bacteria that are responsible for major digestive disturbances, such as acidosis and bloat, and have a chemical structure similar to that of ionophores used in feedlot production. Use of ionophores improves efficiency of feed utilization and decreases the incidence of digestive disturbances that are a major cause of morbidity and mortality in cattle feeding operations. The objectives of this study were to evaluate the effect of beta acid extracts of hops on ruminal fermentation and diet digestibility in cattle fed high-concentrate diets and determine response to different doses of beta acid extracts of hops.

Experimental Procedures

Ruminally cannulated crossbred Angus steers (n = 14; 900 ± 17.5 lb body weight) were used to evaluate the effects of beta acid extracts derived from hops on ruminal fermentation and apparent total tract digestibility of feedlot diets. Treatments were a control (no additive or beta acid extracts of hops); Rumensin (Elanco Animal Health, Greenfield, IN) fed at 300 mg/day; and beta acid extracts of hops fed at 10, 80, 160, 240, or 300 mg/day (approximately 1, 8, 16, 24, and 30 ppm, respectively, of diet dry matter). Rumensin and beta acid extracts of hops were ruminally dosed once daily immediately before feeding.

Steers were housed in individual slatted-floor pens equipped with individual feed bunks and water fountains that allowed free access to feed and clean water. The basal diet was based on steam-flaked corn and contained (dry basis) 10% alfalfa hay and 15% dried distillers grains (Table 1). The diet was mixed, proportioned, and delivered to each pen once daily at 8:00 a.m. Each morning before feeding, unconsumed feed was weighed and dried to determine actual dry matter intake. Four experimental periods were used, each consisting of a 21-day adaptation phase followed by a 3-day collection phase; there were two steers per treatment during each period. Starting 96 hours before the collection phase of each period, chromic oxide (10 g) in gelatin capsules (Torpac Inc., Fairfield, NJ) was placed into the rumen before feeding each day to estimate total fecal output. Ruminal digesta samples were collected at 2-hour intervals to cover 24 hours after feeding during the collection phase of each period and used to determine ruminal pH and ruminal concentrations of ammonia and volatile fatty acids. Fecal samples were collected simultaneously, composited by animal within each period, and used to deter-

[1] The authors acknowledge M.K. Shelor for his technical contributions during this experiment.

mine total tract digestibilities of dry matter, organic matter, starch, neutral detergent fiber, crude protein, and crude fat.

Results and Discussion

Neither Rumensin nor beta acid extracts of hops affected ruminal pH ($P>0.20$) or ruminal concentrations of acetate, propionate, and butyrate and the acetate:propionate ratio ($P>0.50$). Likewise, lactate concentration was not affected ($P>0.30$) by Rumensin or beta acid extracts of hops, but steers dosed with Rumensin tended ($P=0.12$) to have lower ruminal pH than the control group. Cattle that received beta acid extracts of hops tended ($P=0.11$) to have higher ruminal ammonia concentrations than steers fed Rumensin. Isobutyrate concentration in steers fed beta acid extracts of hops was higher ($P=0.03$) than that in control group steers but was not different ($P=0.26$) from that in the Rumensin-fed group. Feeding beta acid extracts of hops also resulted in numerically higher concentrations of isovalerate and valerate relative to the control group.

It is possible that the beta acid extracts are enhancing ruminal protein degradation or reducing bacterial uptake of recycled urea nitrogen. In situations in which ruminal nitrogen requirements are not being met, this effect could be useful and potentially reduce the need for supplemental nitrogen in feedlot diets.

There were no effects ($P>0.20$) of Rumensin or beta acid extracts of hops on intake or total tract digestibility of dry matter, organic matter, starch, crude protein, or crude fat (Table 2). However, several animals that were previously fed 300 mg/day of beta acid extracts of hops indulged themselves in subsequent feeding periods, leading to digestive disturbances and very low feed intake. As a result, data from the 300 mg/day treatment was not included in statistical analysis of dose titration. Dose titration up to 240 mg/day of beta acid extracts of hops had no effect ($P>0.20$) on ruminal fermentation characteristics or diet digestibility.

Implications

Beta acid extracts of hops acids have modest biological activity in the rumen, and this activity might have commercial application.

Table 1. Diet composition of cannulated steers dosed with or without Rumensin or beta acid extracts of hops

Ingredients	% Dry matter
Steam-flaked corn	64.8
Corn dried distillers grains	15.0
Alfalfa hay	9.7
Corn steep liquor	6.3
Supplement[1]	1.9
Premix	2.2
Analyzed composition, %	
Dry matter	83.1
Crude protein	13.7
Ether extract	4.1
Neutral detergent fiber	9.8
Calcium	0.63
Phosphorus	0.45
Potassium	0.68

[1] Formulated to provide 1,000 IU/lb vitamin A; 10 IU/lb vitamin E; 0.3% salt, 0.70% calcium; 0.70% potassium; 0.1 ppm cobalt; 10 ppm copper; 0.15 ppm iodine; 60 ppm manganese; 0.25 ppm selenium; and 60 ppm zinc.

Table 2. Digestion characteristics of ruminally cannulated steers dosed with or without Rumensin or beta acid extracts of hops

	Treatments							
			Beta acid level, mg/day					
Item	Control	Rumensin	10	80	160	240	300	SEM
Intake, lb/day								
Dry matter	19.03	18.11	18.38	18.53	19.93	20.44	18.20	0.56
Organic matter	18.11	17.24	17.43	17.57	18.96	19.43	17.19	0.53
Starch	10.35	9.82	9.99	10.04	10.83	11.10	9.85	0.30
Neutral detergent fiber	2.98	2.83	2.87	2.89	3.14	3.20	2.85	0.09
Crude protein	2.61	2.48	2.52	2.54	2.74	2.81	2.48	0.08
Crude fat	0.79	0.75	0.75	0.77	0.83	0.83	0.75	0.02
Apparent total tract digestibility, %								
Dry matter	77.4	77.6	81.2	78.5	75.4	79.1	76.6	3.16
Organic matter	79.4	80.2	84.0	80.7	78.5	82.2	79.6	2.93
Starch	99.8	99.7	99.8	99.7	99.6	99.8	99.7	0.06
Neutral detergent fiber[1]	39.8	49.5	48.2	43.6	37.0	44.5	40.0	6.37
Crude protein	73.0	73.5	77.1	73.9	70.6	75.4	73.3	3.23
Crude fat	88.7	88.9	92.1	88.9	89.0	90.9	90.8	1.38

[1] Control vs. Rumensin, P=0.06; Control vs. beta acid, P>0.3; Beta acid vs. Rumensin, P=0.07.